Project n°.AURG/2/161

Aval Fonio

Improvement of post-harvest and enhancement of fonio in Africa

First annual report

(December 2012 – December 2013)

Jean-François CRUZ
Coordinator of Aval Fonio project

CIRAD (Centre de Coopération internationale en Recherche Agronomique pour le Développement - France)

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Level of diffusion	
RE	Restricted to a group specified by Coordination

Author: Cruz Jean-François

Cirad (Centre de Coopération internationale en Recherche Agronomique pour le Développement)
UMR Qualisud, Département PERSYST,
TA B-95/16, 73 rue Jean François Breton,
34398 Montpellier Cedex 5, France

This work was conducted in collaboration with the members of the scientific and technical project steering committee of the Aval Fonio project

- **Béavogui** Famoï (IRAG Guinea), Supervisor WP1
- Mme **Sidibé** Salimata **Coulibaly** (IER Mali) Co-supervisor WP3
- **Diallo** Thierno Alimou (IRAG Guinea) Co- supervisor WP2,
- **Ferré** Thierry (Cirad, France), Co-supervisor WP4
- **Goli** Thierry (Cirad, France), Co- supervisor WP3
- **Kébé** Cheikh Mouhamed Fadel (ESP-UCAD, Senegal), Co- supervisor WP3
- **Medah** Ignace (IRSAT Burkina), Co-supervisor WP4
- **Saletes** Sloan (Cirad, France), Valorisation
- **Thaunay** Patrice (Cirad France), Co-supervisor WP2

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Contents

1. Description

1.1. Name of beneficiary of grant contract:

CIRAD - Centre International en Recherche Agronomique pour le Développement
Public Establishment of Industrial and Commercial Nature.

1.2. Name and title of Contact person:

Cruz Jean-François, (jean-francois.cruz@cirad.fr)
Scientific Manager, Cirad, Persyst Department, UMR Qualisud

1.3. Name of partners in the Action:

Partner 1:
IRAG (Guinean Institute for Agronomic Research), Conakry, Guinea
Béavogui Famoï, General Director of IRAG (beavoguifamoi@gmail.com)

Partner 2:
IER (Institute for Rural Economy), Bamako, Mali
Ms Coulibaly Salimata Sidibé, Cheif of LTA/IER (salimatas3@gmail.com)

Partner 3:
IRSAT (Applied Sciences and Technology Research Institute), Ouagadougou, Burkina.
Diawara Bréhima, Director of IRSAT (dirsat@fasonet.bf) (b.diawara@yahoo.fr)

Partner 4:
ESP/UCAD (Polytechnic Higher Training College/Cheikh Anta Diop University), Dakar Fann, Senegal.
Kébé Cheikh Mouhamed Fadel (cmkebe@gmail.com)

1.4. Title of the Action:

Improvement of post-harvest and enhancement of fonio in Africa (“Aval Fonio”)

1.5. Contract number: AURG/161/2012

1.6. Start date and end date of the reporting period:

December 2012, December 2013

1.7. Target countries or regions:

Guinea, Mali, Burkina, Senegal (and Burundi)

1.8. Final beneficiaries and/or target groups[1]:

Final beneficiaries: African fonio commodity chain stakeholders, especially women

Target groups: Producers from Fouta Djallon (Guinea) – Women’s processing groups and SMEs in Burkina Faso, Mali and Senegal - Local equipment manufacturers. National Research Systems in Guinea, Mali, Burkina Faso, Senegal (and Burundi)

1.9. Countries in which the activities take place (if different from point 1.7):
Guinea, Mali, Burkina, Senegal

[1] Target groups” are the groups/entities who will be directly positively affected by the project at the Project Purpose level, and “final beneficiaries” are those who will benefit from the project in the long term at the level of the society or sector at large.

1.10. Action structure

The Action, which is based the complementarity of the partners and their knowledge of the fields of operation, is organised in 5 *work packages* (WPs), described in detail below, and illustrated schematically in Figure 1, which also shows the target groups.

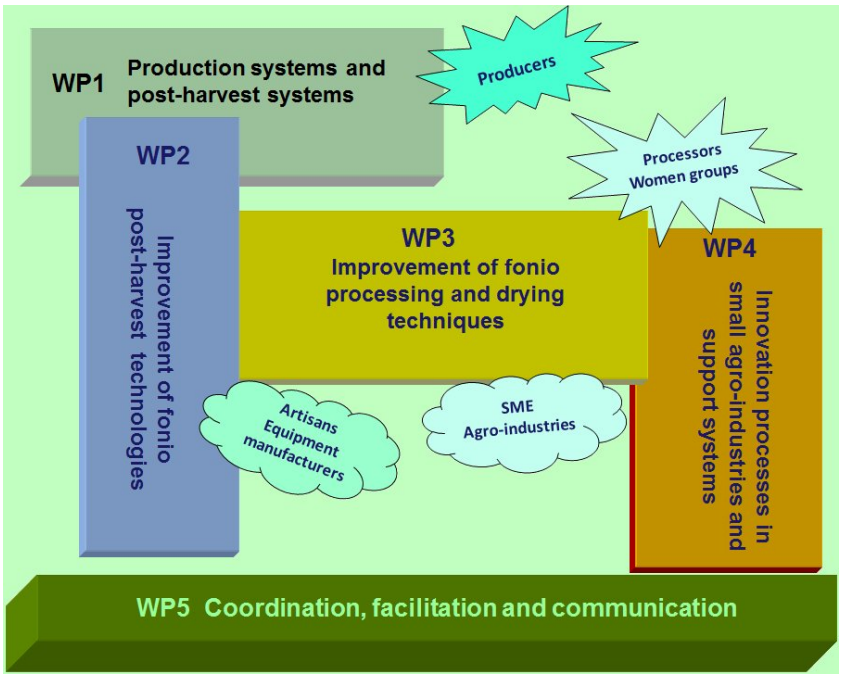


Figure 1: Work packages schematic

The main activities are illustrated in the diagram below (Figure 2).

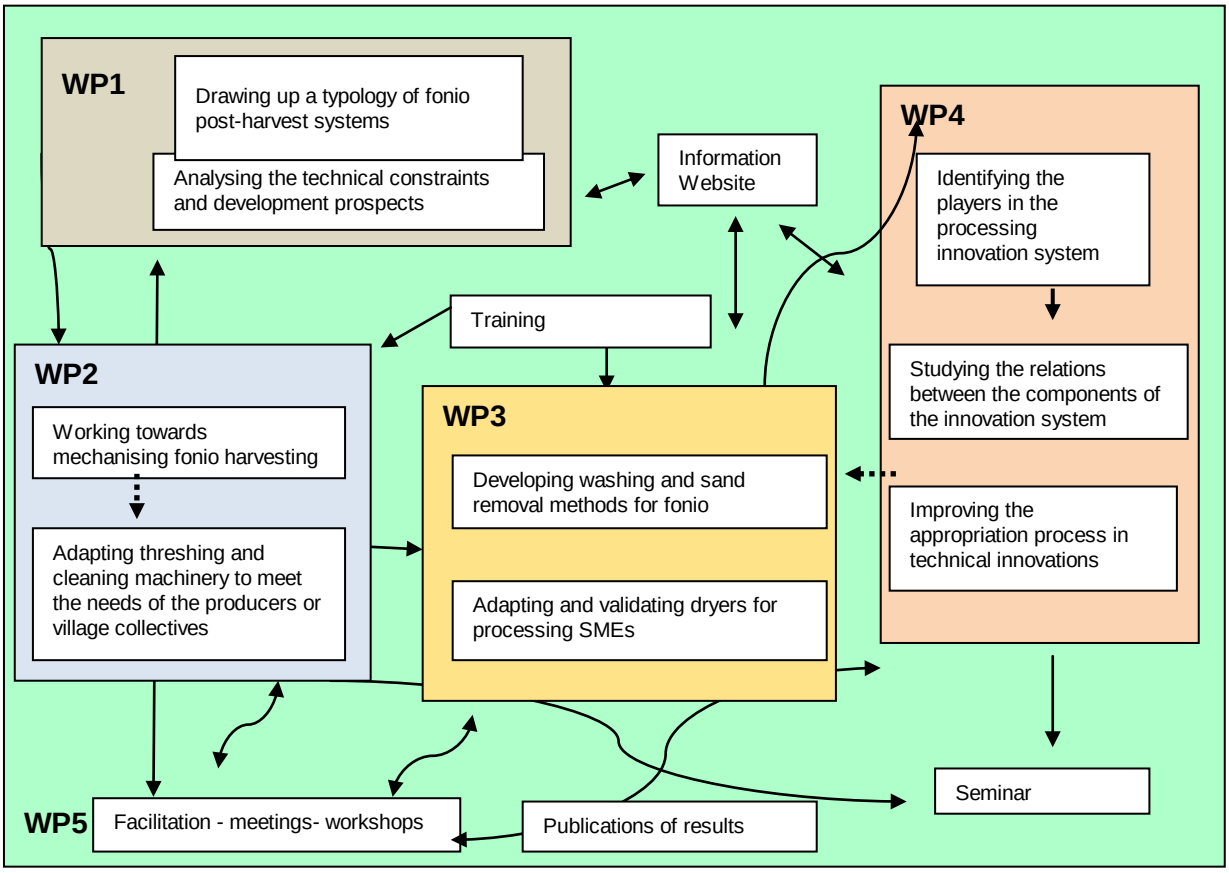


Figure 2. Diagram of the main activities of the Action

2. Assessment of implementation of Action activities

2.1. Executive summary of the Action

The "Aval Fonio" project was ratified at the African Union meeting in Addis Ababa of 17 December 2012.

The contracts with the 4 project partners were prepared, discussed and finalised in January and February 2013, and the contracts signed in early March 2013.

The project launch had initially been scheduled for Conakry (Guinea) from 19 to 22 March 2013. But the serious events which took place in Guinea in early March forced the Coordination to suspend this launch and defer it to April in Senegal.

The kick-off meeting and the initial workshops for the various work packages were held in Dakar (Senegal) from 15 to 19 April 2013. These meetings brought together around forty participants, including researchers and administrative personnel from Burkina Faso, Burundi, France, Guinea, Mali and Senegal, as well as fonio commodity chain stakeholders, mainly processors, and research partners.

In Guinea, the activities for WP1: *Analysis of production and post-harvest systems* were carried out in 10 big villages in Fouta Djallon. For WP2: *Mechanisation of post-harvest techniques*, the trial plots required for the mechanisation tests (harvesting, threshing and cleaning) were planted at the IRAG Bareng Centre (Fouta Djallon) in July 2013. To review these various activities with the partner IRAG, the project coordination had planned to go out to Guinea in September 2013, but this visit had to be cancelled, at the request of IRAG, because of the insecurity generated by the local legislative elections being held. This coordination mission was deferred to 2014. The initial mechanical harvesting and threshing tests took place at the IRAG Bareng Centre (Guinea) between 10 and 30 November, with the participation of Cirad. Certain cleaning trials could not be carried out since the equipment (winnowing channel and rotative sieve) manufactured in Mali could not be manufactured and delivered on time.

Regarding WP3: *Improvement of processing and drying techniques*, the initial washing & desanding studies were launched in Montpellier in summer 2013 (Cirad intern), and 2 large-scale missions on drying were conducted by ESP-UCAD in eastern Senegal and Kayes (Mali) on the one hand, and in Bamako (Mali) on the other hand in collaboration with IER. 2013 was dedicated to selecting dryers (especially the greenhouse dryer) and rigorously choosing the instrumentation. It should be noted that because of the security crisis occurring in Mali in 2013, the project Coordination was not authorised to visit this country to meet the partner IER. This has delayed the progress of the activities in Mali. This situation should change for the better in 2014.

For WP4: *The innovation process in small processing plants*, a student of IRC-SupAgro Montpellier studied and analysed the innovation process in fonio processing in Burkina Faso. She was supervised by IRSAT and Cirad (Cirad support mission to Burkina in June 2013). A workshop for WP3 & WP4, held in Ouagadougou (Burkina Faso) from 18 to 22 November 2013, was used to review the state of progress of the activities for these two work packages.

For WP5, the Coordination organised the kick-off meeting and the initial workshops in April 2013 in Dakar (Senegal), and the WP3 & WP4 meeting, which was held in Ouagadougou (Burkina Faso) in mid-November 2013. The project website went online (English and French versions) in September 2013 (http://aval-fonio.cirad.fr/). A poster on the fonio was produced, for presentation at an international SIAL conference in Brazil. Training in equipment design was conducted at ESP-UCAD in September 2013. An intermediate report was sent to the African Union in October 2013, during the "Aval Fonio" project follow-up mission conducted by the African Union in Senegal (partner ESP-UCAD) in early November 2013.

2.2. Activities and results

The contract activities completed or launched during the period in question are as follows.

2.2.1. **WP1: Analysis of production and post-harvest systems**

The activities of this work package are coordinated by Dr. Famoï Béavogui (IRAG)

Activity 1.1. *Typology of production farms and associated post-harvest systems*

✓ *Surveys conducted*

Analysis of the fonio production systems and post-harvest systems is being conducted on two levels

- Village level
- Farm level (producers)

The study started with drawing up questionnaires (village survey and producer survey), the training of 11 surveyors, the choice of rural districts and villages, and the questionnaires test.

The surveys and observations on the production and post-harvest systems were then launched in the following prefectures and villages:

Table 1. List and characteristics of villages surveyed

Prefecture	Village	Characteristics	Special point
Mamou	Boulivel (Kouaba sia)	mountain & dale location	
Dalaba	Mitti	mountain & dale location	
Pita	Hindé	plain location	with thresher test
	Mangol	plain location	with thresher test
	Horè Oury	mountain location	
Labé	Dalein	mountain location	
	Daara	plain location	with thresher test
	Kouraba	plain location	with thresher test
	Sèghen	mountain location, with plains	
Koubia	Pilimini	gravelly soil with bowé	

Figure 3: Fonio fields on a plain and slopes in Fouta Djallon (© T.A. Diallo, Irag)

The study sites are for the most part situated on plains and slopes, or in the mountains. In all the villages concerned, amounting to a population of nearly 40 000 people (of which 58% women), the fonio fields are mostly outside of the tapades[2].

The initial results of the surveys conducted at village level show that fonio is the main crop in terms of surface area in the study zone, with 80%, followed by rice (20%) and maize (3%); we can also mention potatoes, manioc and peanuts. As a subsistence crop for the producers, fonio is in second place behind rice, but far ahead of maize.

The producer surveys are ongoing, and the entry and processing of the data collected is in progress.

Activity 1.2. *Main producer constraints, and prospects*

This activity was not launched within the period.

2.2.2. **WP2: Mechanisation of fonio post-harvest techniques**

The various tests carried out under this work package are under the responsibility of Thierno Alimou Diallo (IRAG) and Patrice Thaunay (Cirad), co-supervisors of WP2.

Activity 2.1 ***Mechanising the harvesting of fonio***

For the mechanised harvesting trials, 2 trial plots were planted with 2 main fonio varieties chosen by IRAG. A first plot, of 1.6 ha, was sown with the semi-late variety "*Rané*" (intermediate 110-day variety). The second plot, of 1.4 hectares, was sown with the early 90-day variety "*Nathia*". At the edge of the plot, 0.25 ha were sown with "*Konso*", a late variety taking more than 130 days. The plots were set up in early July 2013. The varieties and sowing date (July 2013) were chosen so that the harvest could be carried out in November. For the harvest, the plots will be divided into batches harvested either manually or with a motor mower.

Figure 4: Fonio plot sown with the *Rané* variety (© P. Thaunay, Cirad)

As specified during the project kick-off meeting, a motor mower was purchased by IRAG. It is a rice mower model (RA 175 A), with power 6.7 HP (5 kW), manufactured by Dynamic Agro Industrie in Conakry. Another Dynamic Agro-Industrie motor mower, model JD 170 F, was also provided for the trials.

[2] Tapade: Enclosed plot within the farm in Fouta Djallon (Guinea). The word *tapade* is a Franco-Guinean term probably derived from the Portuguese *tapar:* to close.

Figure 5. Rice motor mowers being tested on fonio (© P. Thaunay, Cirad)

The first fonio mechanical harvest trials carried out at various settings showed that the motor mowers are unable to harvest fonio properly. Only a few useful results could be observed over a short distance (a few metres), with the stems straight in front of the machine. But at maturity, fonio undergoes a very marked lodging phenomenon, when most of the stems drop onto the soil. The current cutting bar on the motor mowers is unable to properly pick up this straw, and we can observe formation of jams above the cutting bar and at the straw conveyor outlet.

These locally manufactured motor mowers are useful because of their fairly simple design, easy drivability and relatively moderate investment cost. But to make it better suited to mechanical fonio harvesting, it appears that the cutting bar system needs to be substantially improved, by installing an efficient pick-up system and efficient straw conveyor system. These tasks must be the focus of the IRAG and Cirad technicians and researchers, in order to carry out further harvesting trials in November 2014.

Activity 2.2. *Adapting the threshers and cleaners*

✓ *Threshers*

A mission was conducted by the IRAG Bareng fonio team in various regions of Guinea, to identify small threshers that could be adapted to fonio. A small thresher was adopted from the mechanisation cooperative Comfar at Faranah (Upper Guinea), and initial tests were carried out in-situ at Faranah during the Cirad-IRAG mission of November 2013.

As this small thresher was originally designed for threshing rice and hulling maize, the thresher's rotation speed had to be adjusted for testing on fonio.

Figure 6. The Comfar thresher (© P. Thaunay, Cirad)

Two initial fonio threshing trials were able to be carried out, obtaining a throughput of approximately 150 kg/h, with threshing quality deemed satisfactory. However, the cleaning system is very rudimentary, and proved to be completely ineffective. IRAG took up the option to purchase this machine and test it at the IRAG Bareng centre during the 2014 season.

Another small machine was purchased by IRAG and transported to the IRAG Bareng centre for testing. It is a small Chinese-manufactured "hold on" thresher (model 5TG), marketed for threshing paddy rice. The machine has a fairly basic design (in particular thin metal plates). The operator holds the sheaves and introduces them into a rotating loop thresher driven by an engine, as illustrated in figure 7. The threshed product is collected in a cyclone mounted on the side of the machine.

Figure 7. The Chinese fine-straw thresher (© P. Thaunay, Cirad)

The initial threshing trials were carried out using "*Nathia*" variety sheaves harvested manually on the IRAG trial plots. The results gave a relatively low throughput (less than 40 kg/h), which is fairly common with this threshing principle, but with satisfactory pre-cleaning and little grain loss.

Further trials will be carried out during the next season, to study to what extent the throughput could be increased while retaining good threshing and pre-cleaning quality.

Finally the ASSI thresher, acquired by IRAG in 2001 under the first fonio project funded by CFC, should be reconditioned for the next test season. It appears that it needs an engine refit, and a set of grilles suitable for fonio.

Figure 8. The ASSI thresher from the "CFC Fonio" project (© J-F Cruz, Cirad)

✓ ***Cleaners***

The Alvan Blanch winnower owned by IRAG for years was restored to working order to enable cleaning trials to be carried out on paddy fonio. It is a manual piece of equipment comprising a fan, a hopper and an alternating movement cleaning unit, with two grilles mounted horizontally and a third sloping grille for eliminating particles smaller than the grains. The grains drop out of the hopper onto the horizontal grilles, which are ventilated by a horizontal air flow generated by the fan. The product is spread over the table by alternating horizontal movement of the grilles, which at the same time causes separation, with the straw carried away while the grains pass through the first two grilles. After cleaning, the separated products are directed to outlet orifices for collection.

(© J-F Cruz, Cirad)

(© P. Thaunay, Cirad)

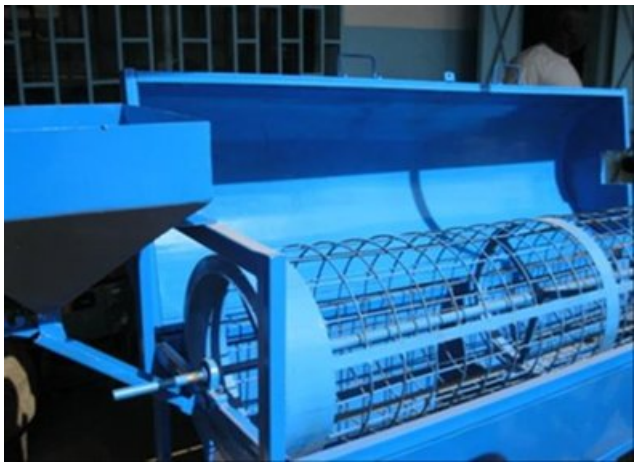
Figure 9. The Alvan Blanch winnower and the fonio cleaning trials at IRAG

During the trials carried out at IRAG in a controlled environment, the mean throughput achieved was more than 200 kg/h at a mean crankshaft rotation speed of more than 70 rpm. Some trials were even able to achieve 400 kg/h, though with an impurity level still high at times.

For new trials to be carried out, it appears that the equipment needs to be motorised, and eventually equipped with wheels to facilitate its mobility.

A **winnowing channel** and **rotative sieve** were purchased, through Cirad, from the manufacturer IMAF in Bamako (Mali), for delivery to IRAG in Guinea. This equipment, manufactured in autumn 2013, was not yet available during the Cirad mission of November 2013, and was only delivered to the IRAG Bareng centre in January 2014.

(© C Marouzé, Cirad)



(© IMAF)

Figure 10. The winnowing channel and rotative sieve manufactured by IMAF

Initial equipment familiarisation trials were carried out with 100 kg of paddy fonio on both pieces of equipment. Some jamming problems were observed on the winnowing system for paddy fonio with a high impurity content (straw). Over the coming months, throughput measuring trials with raw paddy fonio, and more comprehensive trials will be carried out in November 2014 during the new season.

2.2.3. **WP3: Improvement of fonio processing and drying techniques**

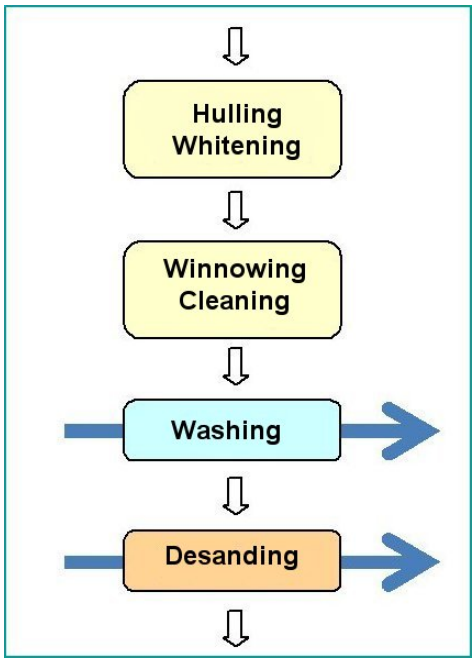
Activity 3. ***Developing washing and sand removal methods for fonio***

The first task of activity 3 involves *Seeking potential improvements to and analysing the functions of washing and sand removal equipment.* To obtain quality fonio after hulling and whitening, all the bran and sand need to be eliminated by washing the grains several times; which increases the processing time and workload. These operations applied to white fonio are two successive operations that must be clearly distinguished, though they are often grouped under the generic term washing.

✓ ***Recap***

Washing, sometimes also termed "pre-washing", consists of eliminating foreign particles and bran still stuck to the fonio grains after hulling/whitening and winnowing/cleaning. Carried out by women, it is traditionally done by hand-mixing the fonio in large tubs filled with water. The bran and light particles are removed with the supernatant contaminated water.

Sand removal consists of eliminating sand grains present in the bleached fonio grains, through a sequence of separation operations carried out using calabashs.



Washing fonio (© J-F Cruz, Cirad)

Sand removal of fonio (© P. Thaunay, Cirad)

Figure 11. Traditional washing and sand removal

Under WP4, observations of traditional washing and sand removal were made in summer 2013 at 6 small companies in Burkina Faso (Ms. Charlotte Martin's internship). The results confirmed that these operations require a large quantity of water (on average 10 l/kg), and that it takes a high number of sand removal operations (5 to 9, depending on the SME).

✓ ***Washing study***

In 2001, under the "CFC Fonio" project, Cirad designed a prototype helical washer as shown in the diagram below.

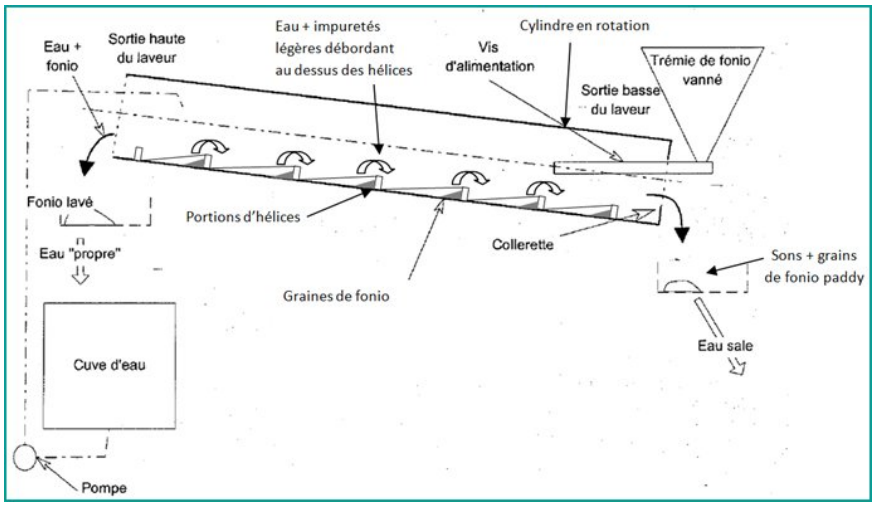


Figure 12. Diagram of helical washer designed by Cirad (© C. Marouzé & P. Thaunay, Cirad)

The washer comprises a sloping helical cylinder, fed with the grains to be washed via the bottom part and with washing water via the top part. The rotation of the helical cylinder enables the grains to be mixed and driven up to the top part. The water fed in, which gradually becomes filled with impurities, is evacuated from the bottom part. On the first prototype (ø 30 cm tube), throughputs of 30 to 50 kg/h were achieved.

Cirad helical washer (© C. Marouzé)

Prototype made in Mali (© C. Marouzé)

Figure 13. Helical washer prototypes

Manufacture of a first prototype was undertaken in 2002 by the cottage-industry manufacturer BCN, but it never became fully functional, and the comprehensive tests could not be carried out.

For its part, in 2013 IER/LTA identified several prototype washers developed in Mali:

- A washer with a capacity of 60 kg of fonio, available from MOD Engineering. This equipment is already installed at a small company in Bamako "Dado production".
- Washers with a capacity of 10 to 15 kg of fonio (with 100 l of water!), manually operated, available from the cottage-industry manufacturer Nana Philomène.

Although these machines are presented as washing/sand removal machinery by their manufacturers, the initial observations made by LTA seem to conclude that they are actually just washers, since "the sand remains present in the washed fonio."

MOD Engineering washer (© F. Guindo, IER)

Nana Philomène washer (© F. Guindo, IER)

Figure 14. Prototype washers identified by LTA in Bamako

Initial tests on the MOD Engineering washer were carried out by IER/LTA at the small Bamako company "Dado production". The trials involved washing 40 kg batches of hulled and whitened fonio. The initial results show that the quantity of water required for washing is approximately 40 l, while it is nearly 150 l for manual washing. This mechanical washing considerably reduces the operation workload, and according to the operators, it produces cleaner fonio (whiter) than manual washing.

IER/LTA is planning to purchase a MOD Engineering washer to carry out comparative tests at the Sotuba laboratory, and confirm the initial observations obtained at the small company "Dado production."

✓ ***Sand removal study***

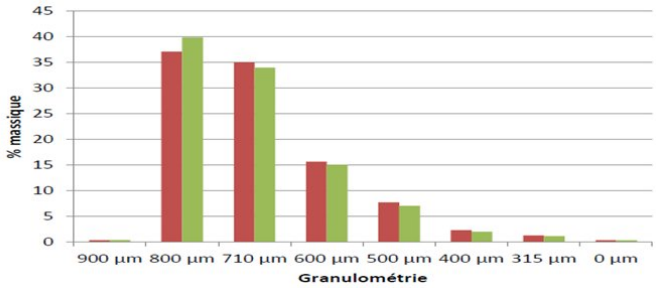
A state of the art review of the washing and sand removal methods was conducted by Cirad in Montpellier as part of the internship of a student (N. Blanc) from Montpellier University 2, on a Masters in Mechanics - Design and Development of Industrial Products. It was supplemented by analysis of the traditional Burkinese method conducted in collaboration with activity 5.1 (internship of Ms. C. Martin). The results were set out in a report:

Blanc N. 2013. Recherche et étude de principes permettant le lavage et dessablage du fonio. Master 1 de mécanique. Université de Montpellier 2. Cirad. Montpellier, France. 58 p. + annexes

Samples were collected from small fonio processing companies in Burkina Faso to conduct physical characterisation of fonio and sand grains.

- *Particle size profiles*

Cirad studied the particle size profile of the fonio and sand grains in a 6 kg sample brought back from Burkina Faso. The analysis shows that the grain size (fonio or sand) varies from 0 to 900 µm. The grain size of whitened fonio is mostly 600 to 800 µm (73%), and to a lesser degree 315 to 600 µm (24%), whereas the sand grain size is mostly from 315 to 600 µm (58%) and to a lesser degree 600 to 900 µm (29%).



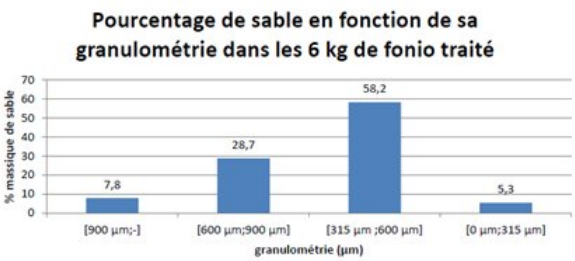


Figure 15. Particle size profiles of fonio and sand

Sand represents 3% of the total sample mass, and 70% of the sand is eliminated in the first sand removal, and more than 95% at the end of the 3rd sand removal.

The significant differences between fonio and sand in specific gravity (1.2 vs. 2.7) and in sedimentation rate (40%) represent an argument for wet separation rather than dry separation.

- *Design of a sand remover model*

After the study, the main wet separation methods which seem potentially useful are the "hydrolift" and "hydrocyclone".

In 2001, under the "CFC Fonio" project, Cirad already designed a hydrolift prototype as per the diagram below.

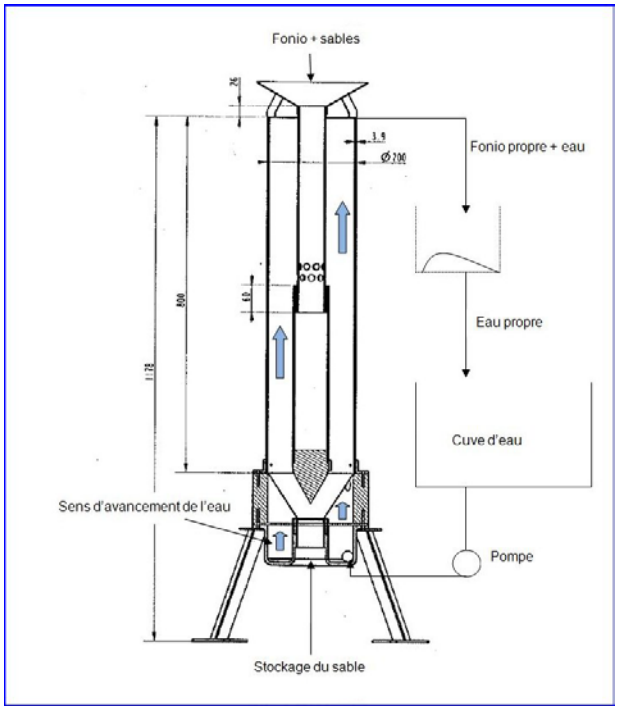


Figure 16. Hydrolift diagram ((© Cirad

The hydrolift tested was able to eliminate up to 90 % of the sand, but that was deemed insufficient to completely eliminate the manual sand removal required to obtain sand-free fonio.

The idea was adopted with a few improvements made, in particular in terms of capacity, in an attempt to achieve throughputs of 60 to 100 kg/h.

A new hydrolift model was manufactured (figure 17), to be tested in the first half of 2014.

The second principle to explore could be the "hydrocyclone", which is well capable of exploiting the specific gravity difference between fonio and sand.

To fairly assess the results of sand removal, it appears that the residual sand in a fonio sample needs to be quantified.

Figure 17. Hydrolift model (© J-F Cruz, Cirad)

✓ ***Developing a method for measuring the quantity of sand in a fonio sample***

Cirad conducted a study into quantifying the sand in a fonio sample.

Several methods were contemplated:

- Calcination at 600°C (Cirad laboratory)
- Starch dissolution and silica assaying (Cirad laboratory)
- X-ray diffraction (European Institute of Membranes laboratory)
- Near-Infrared Spectrometry, NIRS (Cirad laboratory)
- Sensorial analysis (Cirad laboratory)

The difficulty is that 20 grains of sand in 1 kg of fonio represents only approximately 0.01 g, i.e. 0.001% w/w.

The calcination and dissolution tests are in progress.

The X-ray diffraction tests carried out at the European Institute of Membranes in Montpellier were abandoned, since the method proved unsuitable.

The first Near-Infrared Spectrometry (NIRS) tests proved highly promising, detecting the presence of 70 grains of sand per kilogram, i.e. the near threshold of 0.003 %. The tests will be continued with a larger diameter cell, in the hope of detecting the presence of 40 grains of sand per kilogram, thereby achieving the threshold of 0.002%.

Regardless of the adopted laboratory method, we will need to seek to establish a correlation with the sensorial analysis. From what level can sensorial analysis detect sand in the mouth? Preliminary tests carried out at the sensorial analysis at Cirad (Montpellier) on 5-gram samples of fonio consumed by each panellist showed that sand was easily detectable at a rate of 0.008 %. It is planned to continue these sensorial analysis tests in an attempt to determine the consumer perception threshold of the presence of sand.

Figure 18 Sensorial analysis tests at Cirad (© T.Goli, Cirad)

Activity 4. *Adapting and validating dryers for processing SMEs*

During the initial workshops organised in Dakar in April 2013, it was specified that ESP–UCAD would conduct missions in eastern Senegal and Mali (Kayes and Bamako), to meet fonio processing operators (processors, equipment manufacturers, etc.) and survey the experience and opinions of users on greenhouse dryers and cross-flow dryers designed by Cirad under the previous project, “INCO Fonio”.

✓ ***Mission conducted by ESP-UCAD in eastern Senegal and Kayes (Mali)***

An ESP-UCAD mission (C.M.F. Kébé, M. Cissé, N. Ayéssou) was conducted in eastern Senegal and Kayes (Mali) from 3 to 7 August 2013. In Salémata, a settlement to the south of the Niokolo Koba national park, the mission was received by Mr. Mamadou BA (farm manager) and Mr. Mamadou Diallo (retired teacher and facilitator) and met nearly 150 fonio processors, from various women's collectives. In Kédougou the mission was received by the "Koba Club" economic interest group (Ms. A. Ndiaye and associates). The "Koba Club" from Kédougou and fonio processors from Salémata are very interested in testing the dryers validated under the "Aval Fonio" project, and are considered as target groups of the "Aval Fonio" project in Senegal.

Figure 19. Meeting with fonio processors in Salémata(© ESP-UCAD)

In Kayes, in the far west of Mali, the mission visited the NGO "Grenier du paysan" (Mr. Soumaré Singalé), which produces precooked fonio (approximately 70 T per year) for the local market and for export (*Ethiquable* brand). It owns a more compact greenhouse dryer than the one installed by Cirad at Ucodal in Bamako, in 2006. The various information gathered in the course of the discussions are partly being used to redesign the new "solar greenhouse" dryer.

✓ ***ESP-UCAD mission to Bamako (Mali)***

The objective of the ESP-UCAD mission (A. Anne and C. Kane) conducted in Bamako (Mali) from 19 to 24 August 2013 was to meet fonio processors, equipment manufacturers and partners of the IER Food Technology Laboratory. The mission was able to visit the pre-cooked fonio production and marketing companies Ucodal (directed by Ms. Fadima Mariko) and Danaya (directed by Ms. Deme Aïssata Thiam). For equipment manufacturers, it met IMAF, manufacturer of the GMBF fonio huller and of cleaning equipment (directed by Simpara Adama), and MOD Engineering (Mr. Moussa Oumar Diarra), which has more than 20 years' experience in mechanical manufacturing (hullers, mills, etc.) and which in particular, by agreement with Cirad and IER, made the greenhouse dryer now at Ucodal in 2006.

The mission observed that Ucodal had modified the original greenhouse dryer by completely eliminating the ventilation system (axial fans for evacuation of saturated hot air). These modifications definitely reduce the performance of the dryer substantially. Ucodal has also modified the drying tables, which now comprise 3 superimposed racks, whereas originally there was only a single rack. But it seems that the fonio placed on the bottom tray, around 40 centimetres from the floor, has trouble drying correctly. Big temperature differences were observed between floor level and the top of the greenhouse. Furthermore, Ucodal built a new triangular greenhouse dryer, in the hope of facilitating cleaning the plastic cover. In this new dryer, the tables only have 2 trays. Finally, Ucodal invested in a cross-flow dryer running on gas for finishing the drying operations.

Original greenhouse dryer New “triangular” greenhouse dryer

Figure 20. “Solar greenhouse” dryers at Ucodal (© ESP-UCAD)

At DANAYA, the mission observed that the rack dryer CSec-T that had been provided to the company in 2006, under the previous project “INCO Fonio” was still being used, and that the company had invested in a new all-metal box dryer.

Through Ms. Mariko, the mission was able to meet the new management of the company IMAF (Messrs. Adama Simpara, Managing Director, and Abdel Wakil Assogba, Marketing Director). IMAF (Industrie Mali Flexible) is the Bamako equipment manufacturer which Cirad selected, and with which it has collaborated since the early 2000s for the manufacture and sale of various fonio post-harvest equipment, including the GMBF fonio huller, the winnowing channel, etc. It seems that the shop foreman (Mr. Touré Arboncana), with whom the “CFC Fonio” project worked in the early 2000s, is still on the staff at IMAF.

The mission also met with MOD Engineering (Mr. Moussa Oumar Diarra, Director), to which Cirad and IER had entrusted the construction of the first “solar greenhouse” dryer carried out at Ucodal in 2006 under the European project “INCO Fonio”. This company could be called on again to make new greenhouse dryers in Mali.

✓ ***Adapting the dryers, producing prototypes and instrumentation***

The detailed drawings of the “solar greenhouse” and “cross-flow” dryers are available from ESP-UCAD, and still need to be partially modified according to the observations made during the missions and ongoing discussions between Cirad and ESP/UCAD.

For the solar greenhouse dryer, ESP-UCAD contacted a solar greenhouse manufacturer in France (Filclair), which sells agricultural greenhouses with the layout shown in the diagram below:

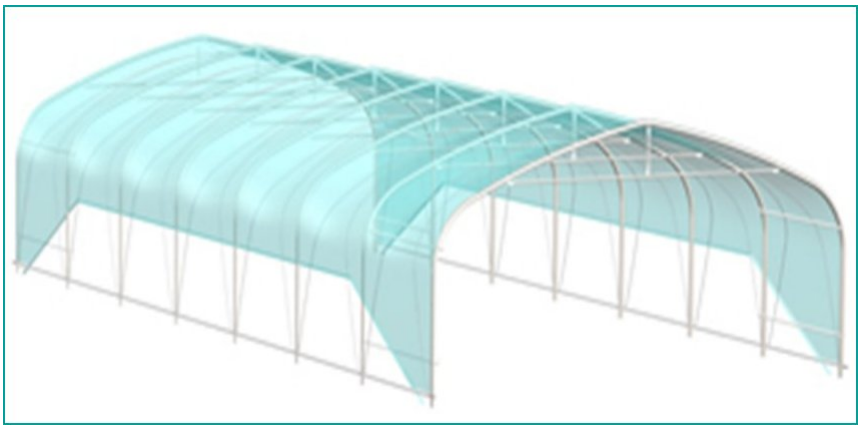


Figure 21. Diagram of a Numeris agricultural greenhouse (doc Filclair)

During the Cirad coordination mission (Cruz J-F) carried out in Dakar in September 2013, various points concerning the “solar greenhouse” dryer were discussed, in particular:

- Solar greenhouse ventilation: though the use of 3 axial air exchange fans in the dryer is being questioned, it appears nonetheless that the greenhouse needs to be equipped with an aeration system to evacuate the hot saturated air that will accumulate on top of the dryer. We contemplated evacuating this air:
  - by natural convection only, using a simple ventilation chimney, such as a wind-powered extractor
  - by forced extraction by means of a low-pressure axial fan, powered for example by a small solar panel.

  These 2 solutions may also be combined, or any other simple solution proposed.
- Construction of plywood gables, to produce an easily dismountable dryer and enable testing of various ventilation configurations. The proposal made by Filclair to ESP-UCAD specifies Plexiglas gables.

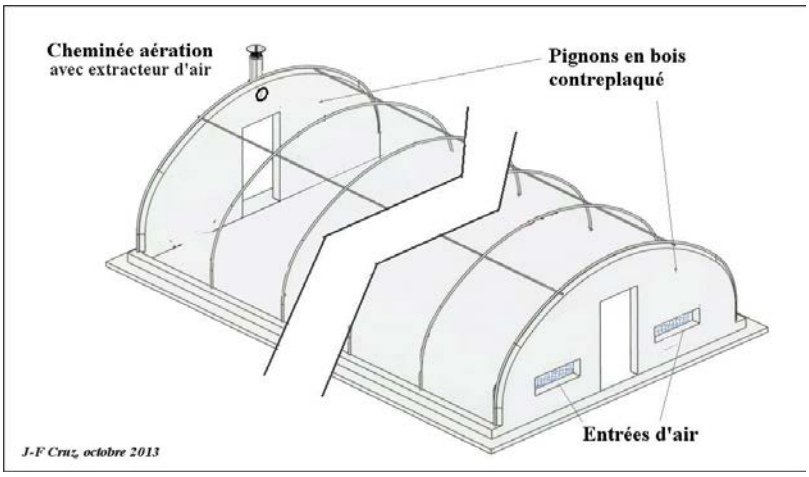


Figure 22. Diagram of greenhouse dryer to be tested

The results of the discussions concluded with the idea of not joining the drying racks to the greenhouse structure. At the prototype stage, it is preferable not to clutter the inside of the greenhouse, so as to be able to investigate various alternative arrangements for the drying stacks.

The dryer instrumentation, defined by Cirad in collaboration with ESP/UCAD, is illustrated in the diagrams below:

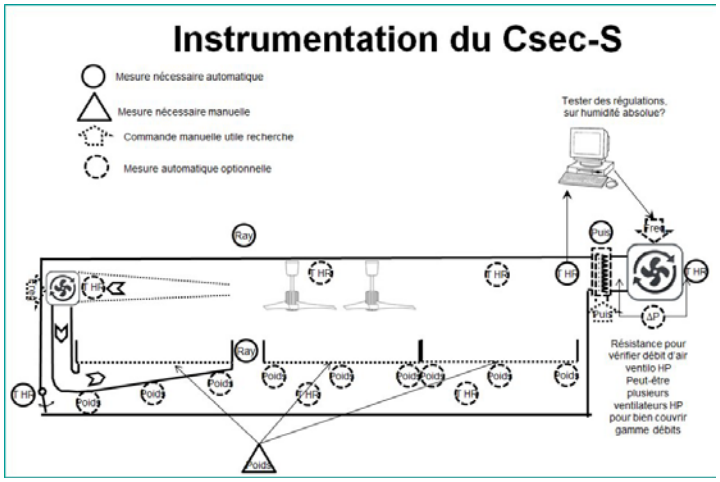


Figure 23. Instrumentation for the “solar greenhouse” dryer CSecS

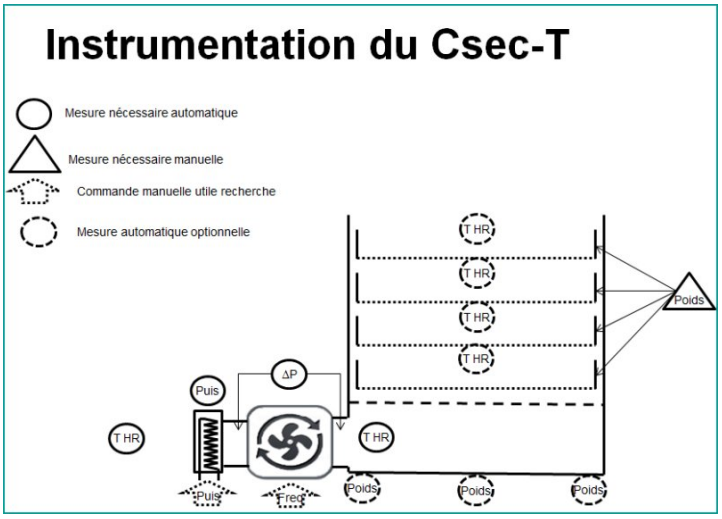


Figure 24. Instrumentation for the cross-flow dryer CSecT

To stay true to the spirit of the "Aval Fonio" project (p. 24 of the project document), the drying activities are to be carried out in 2 phases:

- Start over from the initial prototypes to improve them and validate their performance in a protected environment.
- Transfer the equipment to the field to carry out the tests in a real environment.

The first phase is still in progress, and the "solar greenhouse" dryers (CSec-S) and "cross-flow" dryers (CSec-T) should be available in summer 2014. The prototypes produced will then be tested within ESP-UCAD over the following months, before being installed in a real environment in the eastern Senegal region.

Note: An ESP-UCAD mission (C.M.F. Kébé) to Montpellier (France) was conducted from 11 June to 5 July 2013 on the theme: "*Improving fonio stabilisation technologies.*" This mission (outside the "Aval Fonio" budget) was funded under Cirad's incentive actions for hosting partners from Southern countries.

Activities 3 and 4 are under the responsibility of Cheikh Mouhamed Fadel Kébé (ESP-UCAD), Thierry Goli (Cirad) and Ms. Salimata Sidibé Coulibaly (IER), co-supervisors of WP3.

2.2.4. **WP4: The innovation process in small processing plants**

WP4 is aimed firstly at generating knowledge about the innovation process involving small fonio processing companies. It is also aimed at developing a co-design system of fonio processing and stabilisation technologies (washing, sand removal and drying), bringing in alongside the WP3 researchers the field players (equipment manufacturers, potential users, support structures, etc.) which are also stakeholders in the innovation process.

Activity 5.1: ***Identifying the processing innovation system players***

Going on the assumption that innovation is a process underlines the necessity for joint participation of various stakeholders, alongside the researchers, in the emergence and diffusion mechanisms of innovation. Identifying these players likely to be involved in this process constitutes the first stage in the action.

This activity was covered by an initial study conducted by IRSAT (I. Medah) in collaboration with Cirad (T. Ferré) and IRC [Institute for Hot Regions] – Montpellier SupAgro (Ms. P. Moity). It is primarily based on the 6-month internship of a student from IRC-SupAgro Montpellier (Ms. Charlotte Martin), who spent April to August 2013 in Burkina Faso. She was supervised in the field by IRSAT and Cirad (support mission by T. Ferré in Burkina Faso from 18 to 27 June 2013).

The surveys were conducted in the cities of Bobo Dioulasso and Ouagadougou, as well as in the two main fonio production areas in Burkina Faso, the Boucle du Mouhoun region and the Hauts Bassins region (figure 25).

Figure 25. The survey zones in Burkina Faso

✓ ***Small processing companies***

The starting point of the study is the characterisation of the processing companies. The practices of these units were studied by analysing the operating chains, the supply and marketing strategies. The surveys of the processing units also served to identify the networks of players and organisations to which they are linked.

The study shows that in Burkina Faso, fonio processing by small companies is an activity involving nearly thirty units, dominated by women and concentrated in the cities of Ouagadougou and Bobo Dioulasso. Monitoring twelve of these units has made it possible to characterise them precisely. They are micro or small companies, generally involved in processing several types of cereal (rice, millet, maize and fonio), or even other non-cereal products (yam, tamarind, ginger, bissap, soumbala, etc.). Most of them, eight out of twelve, started processing fonio in the 2000s, and the oldest in 1995.

The diagram below represents in geographic terms the fonio supply and marketing strategies by the small companies, with an added territorial dimension.

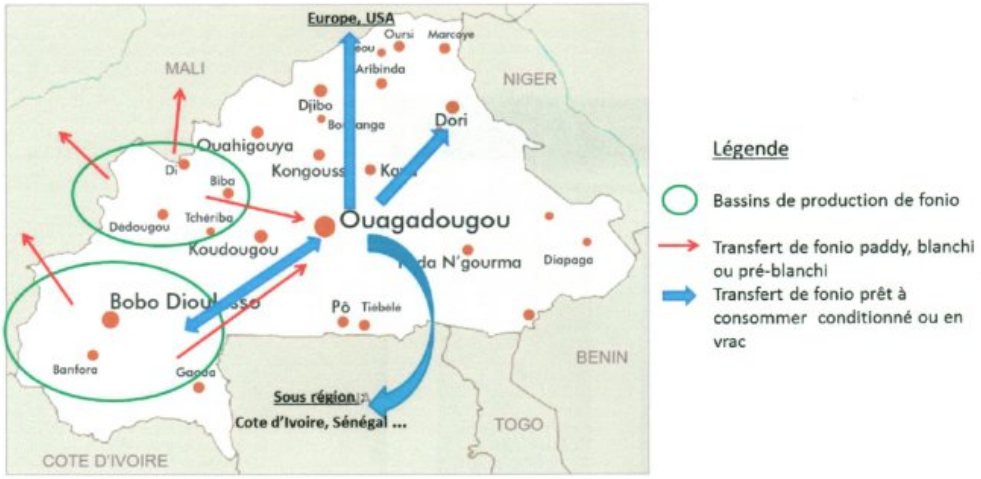


Figure 26. Spatial dynamics of fonio trade in Burkina Faso (© C. Martin,Cirad)

The urban processing companies are more involved in innovations relating to the market launch of new products than to technical innovations. Among these new products, many varieties of fonio-based couscous associated with other starchy products (rice, maize, millet or sweet potato) or with leafy vegetables (green bean or moringa leaves) have been listed. The study also listed savoury or sweet biscuits, spaghettis (mixture of fonio, millet and maize), as well as fonio dégué. These companies have a very low degree of mechanisation. Only four of them are equipped with at least one mechanised production tool, the GMBF huller. Five companies have an annual fonio production of more than 10 tonnes.

Analysis of the company operating chains confirms that the washing and sand removal operations of fonio purchased pre-hulled and bleached by rural processors, is still a long process (throughput 1 to 9 kg/h), and with a very high water consumption (4 to 16 litres per kg of fonio).

Figure 27. Sand removal of fonio in Burkina Faso (© C. Martin,Cirad)

In Ouagadougou, until the mid-2000s, the small companies employed women and girls for hulling and whitening fonio, using a pestle and mortar. These women formed small specialised groups within the units, and were paid by job. This practice has practically disappeared in Ouagadougou; nowadays, manual hulling is carried out by women in rural zones. Demand from the urban SMEs to rural players has generated organisational innovation, with the formation of rural grinding collectives, specialising in manual hulling. These grinding collectives, which work as service providers, are actually officially recognised through an approval certificate issued by the local administration.

The technological and economic analysis of this segmentation of tasks, of this specialisation of self-employed women in the cities, and of this washing/sand removal operation reveals that management of fonio revenue is based primarily on optimising supply costs.

Furthermore, we are witnessing the emergence of private companies specialised in fonio processing (operating with or without service provision), based in the production areas. In fact, the surveys have been able to identify in the cities of Nouna and Bomborokuy (Boucle du Mouhoun), in the heart of the fonio production zones, two companies specialised in processing fonio and equipped with GMBF hullers. The Nouna company, derived from the alliance between a French SME (Gaïa) and an NGO (L'Orange Bleue) produces 22 tonnes of baked organic fairtrade wholemeal or semi-wholemeal fonio per year. This product is primarily aimed at the French market (17 tonnes). The other company, based in Bomborokuy, belongs to a trader, and uses two GMBF hullers to process 10 tonnes of paddy fonio into whitened fonio for the Burkinian and Malian markets.

Figure 28. Hullers GMBF at Bomborokuy in Burkian Faso (© T. Ferré, Cirad)

For the time being, it is a very minor activity, but could be heralding a future change in the redistribution and relocation of the activities within the fonio industry.

✓ ***Analysis of three organisations with various degrees of local rooting***

The surveys conducted among the micro and small fonio processing companies in Ouagadougou were able to identify two initiatives currently structuring the fonio commodity chain. Both are based in a rural setting; one is derived from a local association, and the other from an NGO.

The first was identified by looking into a fonio fair organised in Bomborokouy, in the Boucle du Mouhoun region. Indeed, some of the urban processors from the capital get their raw materials from there, and this event reaches out as far as Ouagadougou and other countries in the sub-region. Understanding the strategy behind this event means having to understand the action of a local association: *Association for the Development of the Department of Bomborokouy* (ADDB).

Figure 29. Bomborokuy, the Burkinese fonio capital (© T. Ferré, Cirad)

The second initiative identified among the urban processors in Ouagadougou is that of a French NGO, *Afrique Verte*, which has proven to be an essential player since it is involved at every stage of the industry. There appear to be two vital components of its operations: firstly organising the supply to urban fonio processing MSEs based on negotiation workshops, and secondly technical support for marketing fonio.

Finally, there is a third system originating from the company *Gaia Bio Solidaire*, which has opted to set up its own private production unit in Nouna, not far from Bomborokouy. This initiative was based on using a GMBF huller and bringing a rural workforce into the unit. This initiative stands out from

previous ones by virtue of its independence, its relationship with the regional players, its commercial logic, making the end product and the target market.

Although ADDB and Gaia Bio Solidaire operate in the same production zone, no form of collaboration has been identified. For its part, the NGO "Afrique Verte" limits its zone of operations to rural environments in the areas of Les Cascades and Hauts Bassins.

Activity 5.1 was covered by an end of study memorandum:

Martin C. 2013. Analyse des processus d'innovation dans la transformation du fonio au Burkina Faso. Projet Aval Fonio. Mémoire de fin d'étude. Montpellier SupAgro. Spécialité Systèmes Agricoles et agroalimentaires durables au Sud (SAADS). Montpellier, France. 110p. + annexes.

This activity is also to be covered by a Cirad–IRAST specific report.

Activity 5.2: *Studying the relations between the components of the innovation system*

For this activity, it is planned for the analysis of the components of the innovation system and interrelations between these components to take as an observation and survey starting point the technical changes and specific equipment appearing in fonio processing, such as the GMBF huller, which was introduced in 2002 under the previous Fonio project funded by CFC.

The analysis of the level of distribution of the GMBF huller is related to the more general issue of explaining the success or failure of the technological innovations. This study was initiated under the internship of the student from IRC-SupAgro Montpellier (Ms. C. Martin), who analysed cases where appropriation of the GMBF huller (a new piece of technology) seemed to have been most tangible. The study covered two small companies in urban locations (Bobo-Dioulasso and Nouna) on the one hand, and a small company located in the rural district of Bomborokouy on the other hand. In all these situations, the hullers work well, with their users satisfied over the long term, with large tonnages at that (around twenty tonnes per year per unit). Although the study covers a limited number of cases, it seems to indicate that appropriation of the GMBF huller depends less on location, rural or urban, than on context of use, the facility or framework in which it is used and the development of local integration in association with the fonio trade dynamics.

The companies studied are based in production areas, and are private facilities by contrast with groups or collectives. The GMBF huller is used there with or without service provision. Conversely, use of the GMBF huller under collective management has proved unfruitful in both the fonio production areas and urban locations.

In Burkina Faso, a specific study on the equipment manufacturers is underway (student Karim Sawadogo from Matourkou CAP [Multi-disciplinary agricultural centre]), which should be able to update our knowledge of these essential players, and also identify those likely to contribute to the co-design of the technical innovations proposed by the "Aval Fonio" project.

The analysis of the innovation process is continuing in 2014.

An IRSAT mission (I. Medah) was carried out in Montpellier (France) from 24 September to 20 October 2013 on the theme: "*Multi-disciplinary approach to the fonio innovation system: analysis of the process of design and appropriation of technical innovations"*. This mission (outside the "Aval Fonio" budget) was funded under Cirad's incentive actions for hosting partners from Southern countries.

Activity 5.3: *Improving the appropriation process in technical innovations*

This activity was not scheduled for the period.

Activities 5.1, 5.2 and 5.3 are under the responsibility of Ignace Medah (IRSAT) and Thierry Ferré (Cirad), co-supervisors of WP4.

2.2.5. **WP5: Facilitation, coordination and communication**

Activity 6.1: ***Creating a website to inform stakeholders***

The project website went online in September 2013. It comprises a French version (http://aval-fonio.cirad.fr/) and an English version (http://aval-fonio.cirad.fr/en).

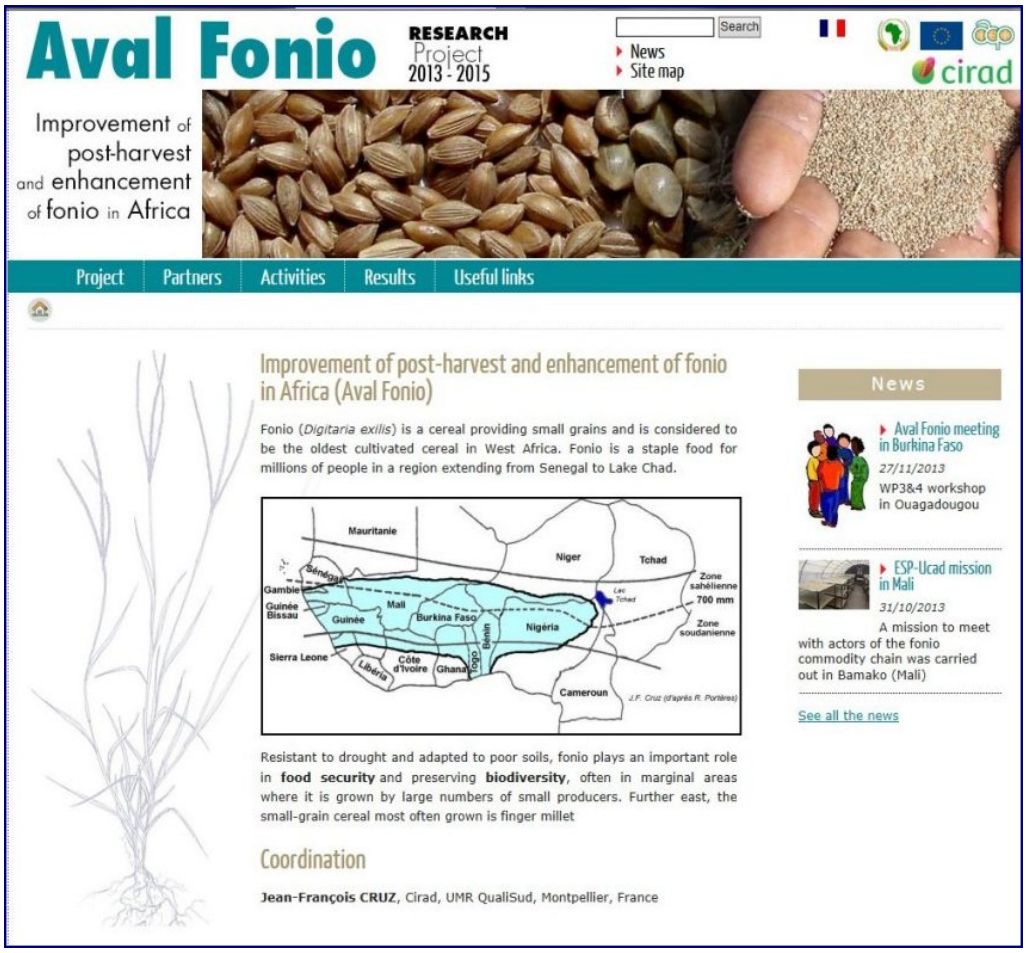


Figure 30. View of the home page of the "Aval Fonio" website

Activity 6.2: ***Organising a seminar, inviting other producer countries***

This activity is not scheduled for the period, but at the end of the project.

Activity 6.3: ***Publication of results in the form of articles and a CD-ROM***

The partners are being encouraged to publish, during the project, outreach articles, "journalistic" short pieces, posters, etc. to raise awareness of the fonio in general, and/or of the results obtained under the "Aval Fonio" project in particular. A poster on the fonio was produced by Cirad in collaboration with IRSAT, and presented at the 6th Global Food Marketplace conference (SIAL), held in Florianopolis (Brazil) in May 2013. The only communication about Africa, with all the others (more than 120 communications) relating to Latin America, this poster enabled the 150-odd participants to discover fonio and learn about the existence of the "Aval Fonio" project.

Poster

Cruz J-F, Ferré T., Medah I., Goli T. 2013. Valorisation d'une céréale africaine: le fonio (Digitaria exilis Stapf). Cirad, Irsat, Syal. Congrès International des Systèmes agroalimentaires localisés (SYAL), Florianopolis, Brésil

Activity 7.1: *Organising and facilitating specific workshops and the annual meetings*

✓ ***Project kick-off meeting and workshops***

The kick-off workshop for the "Aval Fonio" project was held in Dakar from 15 to 19 April 2013.

Under the aegis of Cirad and ESP-UCAD, it brought together around forty participants, including researchers and administrative personnel from Burkina Faso, Burundi, France, Guinea, Mali and Senegal, as well as stakeholders of the fonio commodity chain, mainly processors, and research partners.

At the plenary meeting of 16 April 2013, the Director of ESP/UCAD, Mr. Mamadou Adj who was chairing the launch, hailed the opportunity represented by this project to better develop fonio, a local cereal, and contribute to strengthening collaboration between the various research teams from the sub-region and Cirad. Then the Cirad Regional Director, Mr. Denis Depommier, who co-chaired the launch, spoke of his satisfaction at consolidating the scientific cooperation already in progress, with ESP/UCAD and the other partners in the field of "accessible and quality food", which is one of Cirad's six priority lines of research. Then the project General Coordinator, Mr. Jean-François Cruz, reiterated the history of fonio research and set out the main components of the "Aval Fonio" project. Finally, the partners presented their respective institutions and skills with regard to the "Aval Fonio" project.

Figure 31. "Aval Fonio" project kick-off meeting in Dakar (Senegal)

The thematic workshops were held on 17 April 2013, bringing together around thirty participants. On the one hand they related to work packages WP1 (Analysis of production and post-harvest systems) and WP2 (Mechanisation of fonio post-harvest technologies), and on the other hand work packages WP3 (Improvement of fonio processing and stabilisation techniques) and WP4 (The innovation process in small processing plants). These various thematic workshops enabled the researchers and administrative personnel to specify the content, calendar and management method of the activities to be carried out during the first year of the project. The feedback on the discussions and work summary were conducted on the morning of 18 April during the project steering committee meeting, which brought together the various supervisors and co-supervisors of the various work packages. The afternoon of 18 April was reserved for visiting the various laboratories at ESP-UCAD.

The project kick-off meeting and workshops were covered by a specific report:

Cruz J-F. 2013. Réunion de démarrage et ateliers. Projet Aval Fonio. Cirad, 20 p. + annexes

✓ ***Cirad coordination mission to Senegal, in September 2013***

A coordination mission was conducted in Senegal by Cirad (Jean-François Cruz) from 25 September to 2 October 2013. The object of this mission was to meet the "Aval Fonio" project supervisor for Senegal (Fadel Kébé) and the ESP-UCAD personnel involved in the project. It enabled a review of the research in progress specifically under activity 4 regarding *Adapting and validating dryers for processing SMEs*. The administrative and financial aspects (current expenditure, documentary proof, time sheets, etc.) were also covered.

The coordination mission in Senegal was covered by a specific report.
Cruz J-F. 2013. Rapport de mission au Sénégal. Projet Aval Fonio. Cirad, 7 p.

✓ ***African Union follow-up mission to Senegal in November 2013***

An "Aval Fonio" project follow-up mission was conducted in Senegal, on 4 and 5 November 2013, by representatives of the African Union (Mr. Dereje Belachew and Ms. Monica Ebele Idinoba). It was received by the ESP-UCAD partners under the guidance of the "Aval Fonio" project supervisor for Senegal (Fadel Kébé).

To facilitate the work of this mission, the project coordination sent out to the African Union on 30 October 2013 an intermediate report illustrating the state of progress of the project as at late September 2013.
Cruz J-F. 2013. Rapport intermédiaire. Projet Aval Fonio. Cirad, Montpellier, 20 p.

✓ ***WP3 & WP4 workshop in Ouagadougou (Burkina Faso)***

The WP3 and WP4 workshop was organised jointly between Cirad - IRSAT in Ouagadougou (Burkina Faso). In the project document, this workshop had initially been scheduled for February 2014, but because of the many tasks already underway within work packages 3 & 4, it seemed necessary to bring forward the date that this workshop was held, so that the partners concerned could draw up a specific review of the research in progress, and fine tune the schedule of activities for the year 2014.

Figure 32. Participants at the WP3 & WP4 workshop, Ouagadougou (© J-F Cruz, Cirad)

The workshop, which was held from 18 to 22 November 2013 at the headquarters of the Cirad Regional Office in Ouagadougou, brought together around ten "Aval Fonio" project researchers and technicians from Burkina Faso, France, Mali and Senegal. It provided the opportunity to meet fonio processors in Ouagadougou, and visit the laboratories at IRSAT, an "Aval Fonio" project partner in Burkina Faso.

The workshop was covered by a specific report.
Cruz J-F., Goli T, Ferré T. 2013. Rapport de l'atelier des WP3&4 à Ouagadougou (Burkina Faso). Projet Aval Fonio. Cirad, Montpellier, 25 p. Cruz J-F., Goli T, Ferré T. 2013. Rapport de l'atelier des WP3&4 à Ouagadougou (Burkina Faso). Projet Aval Fonio. Cirad, Montpellier, 25 p.

Activity 7.2: *Training the partners*

At the request of the partner ESP-UCAD, the CAD training initially planned under the project was replaced by training entitled "Equipment design method". In fact, ESP/UCAD personnel already possessing specific CAD software wanted to be allocated specific "equipment design" training, rather than purely CAD training. The budget initially allocated for software purchase was reserved for purchasing additional laptop computers, and partially covering the cost of the Cirad trainer.

The training conducted by Cirad (P. Thaunay) was held from 21 to 28 September 2013, at ESP-UCAD in Dakar (Senegal). It was taken by 6 participants (ESP engineers or technicians), and dealt with equipment design methods, and more particularly functional analysis methods.

The training session was covered by a specific report.
Thaunay P. 2013. Formation Méthode de conception d'équipements à l'ESP-UCAD. Projet Aval Fonio. Activité 7.2., Cirad, 37 p. + annexes

2.3. Modified activities (put back or brought forward)

The main activity which has undergone modifications from the original project is activity 7.1. *Organising and facilitating specific workshops and the annual meetings*

In the project document, the provisional table of meetings and workshops for the first 2 years of the project was as follows:

Meetings or workshops	Country	Participants	Month	Duration (days)
Kick-off workshop	Guinea	Steering committee + partners and researchers	3	3
WP1 & WP2 workshop	Guinea	Researchers and concerned local partners	3	2
WP3 & WP4 workshop	Senegal	Researchers and concerned local partners	6	4
Annual meeting	France	Steering committee + concerned local researchers	12	4
WP3 & WP4 workshop	Mali	Researchers and concerned local partners	14	2
WP1 meeting	Guinea	Researchers and concerned local partners	17	3
WP2 & WP3 workshop	Senegal	Researchers and concerned local partners	18	3
Annual meeting	Burkina	Steering committee + local partners	24	4

✓ *Project kick-off meeting and workshops*

The project launch had originally been organised by Cirad and IRAG in Conakry (Guinea) for 19 to 22 March 2013. It was to be followed up by a workshop for WP1 & WP2, to be held in Labé (Fouta Djallon) from 25 to 27 March 2013. But the serious events which took place in Guinea in early March forced the Coordination, by agreement with IRAG and the other project partners, to suspend this launch, so as not to take needless risks.

As the WP3 & WP4 workshop was scheduled for June 2013 in Senegal, it appeared logical to combine the first 3 meetings and organise the kick-off meeting and the workshops for the various work packages for April in Senegal (see activity 7.1 description).

✓ *Annual meeting in France*

Since the project kick-off came only in April 2013, it was decided that the annual meeting, originally scheduled for Montpellier in December 2013, be held instead in April 2014 (week 15 from 7 to 11 April 2014), i.e. 1 year after the Dakar meeting. Hence this report will give the WP supervisors more time to process and above all analyse the host of results that they should have acquired by the end of 2013. All the WP2 tests relating to fonio harvesting, threshing and cleaning are highly dependent on the crop calendar, and did not take place until mid-November 2013. A meeting in December would not have provided enough time to properly analyse the results of the initial tests.

✓ *Workshop for WP3 & WP4 in Ouagadougou (Burkina Faso)*

This workshop, initially scheduled for February 2014, was brought forward to November 2013 (from 18 to 22 November 2013) to enable the partners to specifically review the research in progress, and thoroughly prepare for the activities planned for 2014. It also enabled Cirad to combine this workshop with a coordination mission to the partner IRSAT.

✓ *Coordination mission to Guinea and Mali*

The Cirad coordination had scheduled a mission to the partner IRAG in Guinea for 28 September to 2 October 2013. This mission, combined with the coordination mission conducted in Senegal, had to be cancelled at the last minute at the request of the partner IRAG, because of risks of disorder in Conakry (legislative elections in Guinea). This mission has been deferred to a later date.

The Cirad coordination also wanted to conduct a mission in Mali, to the partner IER, during the first year of the project. But because of the war situation in the country, Cirad did not authorise its personnel to visit Mali in 2013.

That was also why the workshops for WP3 & WP4 originally due to be held in Mali were ultimately held in Burkina Faso.

The updated table of meetings and workshops is as follows:

Meetings or workshops	Country	Participants	Month	Duration (days)
Kick-off meeting	Senegal	Steering committee + partners and researchers	15-16 April 2013	2
WP1 to WP4 workshop	Senegal	Researchers and concerned local partners	17-19April 2013	3
WP3 & WP4 workshop	Burkina Faso	Researchers and concerned local partners	19-21 November 2013	3
Annual meeting	France	Steering committee + concerned local researchers	7 - 11 April 2014	4
WP1 to WP4 workshop	Mali	Researchers and concerned local partners	9 – 13 June 2014	3
WP1 to WP4 workshop	Guinea	Researchers and concerned local partners	November 2014	3
Annual meeting	Burkina Faso	Steering committee + local partners	February 2015	4
WP1 to WP4 workshop	Mali	Researchers and concerned local partners	June 2015	3
Annual meeting	Senegal	Steering committee + local partners	October 2015	4
Final seminar	Burkina Faso	Steering committee + Researchers, local partners, decision makers, NGOs...	November 2015	4

Table 2: Updated calendar of meetings and workshops

2.4. “Aval Fonio” project results.

2.4.1. Observations on the execution and achievements of the activities

All the activities have been launched, but many of them several months late, since the “Aval Fonio” project only really started in April 2013 with the organisation in Senegal of the kick-off meeting and the initial work package workshops.

The surveys from WP1 on the fonio production and post-harvest systems went smoothly, and the analysis of the results is still in progress. The report should be available during 2014.

For WP2, the initial mowing equipment trials were dissatisfactory, because of the significant lodging of the fonio stems. Substantial modifications will be made to the cutting bar on the motor mowers in April - May 2014 so that the machines will be in working order for the next season (October - November 2014). To carry out the mechanised harvesting trials, trial plots will be planted from June –July 2014. Regarding the threshing equipment, the preparation is also due to be carried out in April –May 2014:

- Modification of the Comfar thresher
- Identification of a small thresher in the Kérouané region
- Reconditioning of the Assi thresher, and prospecting a compact-model Assi in Senegal

Regarding the cleaning equipment, the equipment purchased in Mali (winnowing channel and rotative sieve) could not be delivered for the 2013 season. So the trials on this equipment were put back to the 2014 season, although in the meantime some preliminary tests may be carried out with “raw” fonio.

For WP3, the design of an “improved hydrolift” model took much longer than planned, and the initial laboratory tests will only be able to be carried out in April-May 2014. The manufacture of the initial pilot prototype is not scheduled until the end of 2014, i.e. more than 6 months later than the original schedule. Regarding the washing equipment, a delay of several months has also been observed, partly due to the impossibility for Cirad researchers of visiting Mali during 2013.

The adaptation of the drying equipment - “cross-flow” dryer and “solar greenhouse” dryer - took much longer than originally assumed. It has actually been decided to validate the dryers in a protected environment (ESP-UCAD site) to ensure better control the subsequent trials in a real environment, once the equipment has been transferred to the field. The selection of the dryers, in particular the greenhouse dryer, and the choice of instrumentation, were highly rigorous processes, causing a delay of several months. Construction of the prototypes on the ESP site is scheduled for 2014, with the initial tests to be carried out in autumn 2014. A first solar greenhouse should be installed with the processors in eastern Senegal in the second half of 2014.

For WP4, the activities are going smoothly, and a report “The players in the fonio processing innovation system in Burkina Faso” is due to be written for June 2014. Like the work carried out in Burkina Faso in 2013 with the support of a student intern (Ms. Charlotte Martin) from IRC SupAgro, a study will be conducted in Mali from April to September 2014 on “innovation processes in small fonio processing units in Bamako” (intern: Ms. Kadidiatou Coulibaly) in collaboration with the IER Food Technology Laboratory.

Regarding WP5, activities 6.1 (Website) and 7.2. (Partner training) have finished, having been completed as per the provisional schedule. The other activities are in progress, and those modifications made to the calendar of the various meetings or workshops were described in paragraph 2.3. “Modified activities”.

2.4.2. Contract of more than €10 000

In the project, the only expense of more than €10 000 related to the purchase of a pick-up truck by IRAG in Guinea (see invoice below).

SETA-GUINEE

I.R.A.G
P/C
PROJET AVAL FONIO
Conakry GUINEE

Conakry le ; 17 mai 2013

FACTURE **49000**

DESIGNATION	Qté	Prix Unitaire	TOTAL
MITSUBISHI L 200 DC AC GL 2,8 D 4x4 Modèle : KB7TNJNML CHASSIS: MMBJNKB 70 DD 026718			
Prix Hors TVA (Clés en main)	1	27 494 EUR	27 494 EUR

PAIEMENT **100% A LA LIVRAISON SUR NOTRE COMPTE S G B G N° 00003 00001 01516110013 67**	HTVA	27 494 EUR
	TVA + 18%	4 949 EUR
GARANTIE : SELON CONDITIONS CONSTRUCTEUR 2 ANS OU 50 000 KMS LE 1er TERME ECHU	TOTAL TTC	**32 443 EUR**

ARRETEE LA PRESENTE FACTURE A LA SOMME DE : ***TRENTE DEUX MILLES QUATRE CENT QUARANTE TROIS EUROS***

La Direction

Société d'Equipement Technique et Automobile * SETA - GUINEE * Tél: 64 37 36 89 BP: 1012

MITSUBISHI MOTORS · Mercedes-Benz · KIA MOTORS · MICHELIN

Société Anonyme au Capital de 650 000 000 GNF - Agr. n° 706/SEC/DCI/DPCI - R.C. n° 861/G/TPV/CKY/87 - TVA n° 0000655F2T
Route du Niger Km9 Matam Lido - Tél.: 00 64 67 14 / 64 37 36 89 - E-mail: seta-guinee@biasy.net
BP: 1012 Conakry GUINEE

Figure 33. Purchase invoice for the "Aval Fonio" project vehicle by IRAG in Guinea

2.5. Updated action plan (2014)

Year 2													
	Semester 1						Semester 2						
Activities	1	2	3	4	5	6	7	8	9	10	11	12	Implementing body
Preparation1.1 (done)													IRAG
Execution activity 1.1 Systems typology													IRAG
Preparation activity 1.2 Analysis technical constraints													IRAG
Execution activity 1.2 Analysis technical constraints													IRAG/Cirad
Preparation activity 2.1 Mechanising the harvesting of fonio													IRAG/Cirad
Execution activity 2.1 Mechanising the harvesting of fonio													IRAG
Preparation activity 2.2 Adapting threshers and cleaners													IRAG, Cirad
Execution activity 2.2 Adapting threshers and cleaners													IRAG, Cirad
Preparation activity 3 Developing washing and sand removal processes													Cirad, IER
Execution activity 3 Developing washing and sand removal processes													IER, Cirad,
Preparation activity 4 Adapting and validating dryers													Cirad, ESP-UCAD
Execution activity 4 Adapting and validating dryers													ESP-UCAD, Cirad
Preparation activity 5.1 (done)													IRSAT, Cirad
Execution activity 5.1 Identifying the processing innovation system players													IRSAT, Cirad
Preparation activity 5.2 (fait)													IRSAT, Cirad
Execution activité 5.2 Studying the relations between the components of the innovation													IRSAT, Cirad
Preparation activity 5.3													IRSAT, Cirad
Execution activity 5.3 Improving the appropriation process in technical innovations													IRSAT, Cirad
Preparation activity 6.1 (fait)													Cirad
6.1 Website running													Cirad
Preparation activity 7.1 Organising and facilitating workshops and meetings													Cirad + partners
Execution activity 7.1 Organising and facilitating workshops and meetings													Cirad + partners
Preparation activity 7.2 (done)													Cirad
Execution activit 7.2 (done)													Cirad

3. Partners and other cooperation

3.1. Relations between "Aval Fonio" project partners

The coordination did not encounter any particular difficulties with the partner institutions in implementing the "Aval Fonio" project. Quite the opposite, the coordination would like to praise the commitment, energy and team spirit demonstrated by all the work package supervisors and all the operatives involved in the project.

3.2. Relations with State authorities in the project countries

The main difficulties encountered are down to the unstable social and/or political situation in certain partner countries such as Mali or Guinea.

For instance, the Cirad coordination wanted to conduct a mission in Mali, to the partner IER, during the first year of the project. But because of the war situation in the country, Cirad is still not authorising its personnel to travel to Mali.

Cirad had also planned a joint mission to the partner IRAG in Guinea in late September-early October: coordination mission (J-F Cruz) in Conakry, and WP2 mission (P. Thaunay) in Labé in preparation for the fonio harvesting, threshing and cleaning trials. These missions were cancelled at the request of the partner IRAG because of the risks of disorder in Conakry (legislative elections on 28 September in Guinea).

We can only hope that the situations calm down in the future, so that the coordination missions and workshops might be organised and conducted there.

3.3. Relations with any other organisation involved in the project implementation:

- **Associates:**

CNTA (National Centre for Agri-Business Technology) in Burundi. In April 2013, a specialist in post-harvest technologies from CNTA, Mr. Stany Ntahomvukiye, was invited to take part in the "Aval Fonio" project kick-off meeting, and in the WP2 workshop. Mr. Stany Ntahomvukiye is also invited to take part in the project 2014 annual meeting. A follow-up mission is planned by Cirad (J-F Cruz) in March or April 2015 to Burundi, to review the finger millet commodity chain, in collaboration with CNTA.

IRC-SupAgro in Montpellier (France) is closely collaborating with the activities of WP5 in partnership with IRSAT and Cirad. IRC SupAgro (Ms. P. Moity) specifically took part in the execution of activity 5.1 *Identifying the processing innovation system players*. A student (Ms. C. Martin) who took an internship of more than 5 months in Burkina Faso was co-supervised scientifically and educationally by this Institute. IRC SupAgro will also co-supervise the internship of Ms. Kadidiatou Coulibaly on the innovation processes in small fonio processing units in Bamako, due to run from April to September 2014.

- **End beneficiaries and target groups**

The "Koba Club" association for women fonio processors in eastern Senegal was invited to take part in the "Aval Fonio" project kick-off meeting in Dakar in April 2013. Several representatives of this association attended, including the Chairwoman (Ms. Aïssatou Ndiaye), and they expressed their wish to be closely associated with the project. Hence an ESP-UCAD mission was subsequently conducted to Kédougou in August 2013 to meet the association members and discuss the terms of work. This same mission also met women fonio processors from the village of Salémata (see Activity 4). In 2014, a student intern from IRC-SupAgro Montpellier (Ms. Sarah Gaucher) supervised by Cirad (J-F Cruz) and ESP-UCAD (C.M. F. Kébé) will spend the summer in eastern Senegal to study the small fonio processing companies in the regions of Kédougou and Salémata, paying particular attention to the needs of the fonio processors in terms of technical innovations.

The Director of UCODAL (Ms. Fadima Mariko) in Bamako (Mali) was also invited to take part in the "Aval Fonio" project kick-off meeting in Dakar. This Malian processor is one of the pioneers in pre-cooked fonio production in West Africa, and has already collaborated closely with all the previous fonio projects. She will be closely associated with the studies conducted under WP3 and WP4.

In Burkina Faso, several women's fonio processing collectives and small fonio processing companies were surveyed as part of Activity 5.1 Identifying the processing innovation system players.

All these players were closely involved in the execution of the study, as were some of their associations such as ATCB (Burkina Faso association of cereal processors) or ADDB (Association for the development of Bomborokuy Department) (http://addb-yoromu.org/)

Localisation	Numero entreprise	Catégorie	Produits transformés	Produits fonio
Ouagadougou	1	Micro entreprise	riz-fonio-mil-maïs-igname	fonio non précuit, fonio précuit
Ouagadougou	2	Micro entreprise	riz-fonio-mil-maïs-tamarin-gingembre-bissap	fonio non précuit, fonio précuit, couscous *forima* (fonio-riz-maïs), couscous *fonihoco* (fonio-feuille de haricot)
Ouagadougou	3	Micro entreprise	riz-fonio-mil	fonio non précuit, fonio précuit, spaghettis fonio-mil-maïs
Ouagadougou & Bobo-Dioulasso	4	Micro entreprise	riz-fonio-mil-maïs-igname-lentilles	fonio non précuit, fonio précuit, (degué fonio-patate douce)
Ouagadougou	5	Micro entreprise	riz-fonio-mil-bissap-soumbala-épices	fonio non précuit, fonio précuit
Ouagadougou	6	Micro entreprise	riz-fonio-mil-maïs-igname-tamarin-gingembre-bissap-épices-haricot-karité	fonio non précuit, fonio précuit, couscous de fonio ,couscous de fonio-moringa, (couscous patate douce -fonio)
Bobo-Dioulasso	7	Micro entreprise	riz-fonio-mais-mil-igname-gingembre-bissap	fonio non précuit, fonio précuit, couscous
Bobo-Dioulasso	8	Micro entreprise	riz-fonio-mil-pain de singe-mais	fonio non précuit, fonio précuit, farine pour Tô, degué
Bobo-Dioulasso	9	Petite entreprise	riz-fonio-mil	fonio non précuit, fonio précuit, degué, biscuit salé et sucré
Bomborokouy	10	Petite entreprise	fonio	fonio blanchi
Bomborokouy	11	Groupement de transformatrices (Brayorona-ADDB)	fonio-karité-bissap	fonio non précuit, fonio précuit
Nouna	12	Petite entreprise (Gaia Bio Solidaire)	fonio	fonio étuvé complet et semi-complet

Table 3. Companies studied under activity 5.1 in Burkina Faso

In Guinea, it is more the fonio producers which are associated with the "Aval Fonio" project, since the WP1 & WP2 activities relate to the upstream part of the commodity chain.

Under WP1, IRAG surveyed 10 villages of 5 prefectures in Middle Guinea (see table 1). Most of these villages or settlements had already collaborated in previous fonio projects. The particular case of the village of Pilimini in Koubia prefecture is interesting, since it is the focus of interest of the Franco-Guinean association ADESAG (http://www.adesag.com/), association for the development of Solidary Entrepreneurship in Africa and Guinea (Ms. H. Baldé) that wishes to collaborate with the "Aval Fonio" project.

- **Other third parties involved (NGOs, etc.)**
  As part of the "Aval Fonio" project activities, and in particular for WP3 and WP4, the researchers have had occasion to meet and collaborate with NGOs, as in Burkina Faso: *Afrique Verte*, *Ocades* (Catholic organisation for development and solidarity) or in Mali, *Le grenier du paysan* from Kayes.

4. Visibility

The project document refers to various actions planned to raise the profile of the contribution of the African Union and European Union to the "Aval Fonio" project.

Several actions were carried out over the period.

4.1. "Aval Fonio" project website

The website (in French and English) dedicated to the "Aval Fonio" project refers to the funding granted by the African Union (EuroAid procedure), and links to these Institutions have been set up.

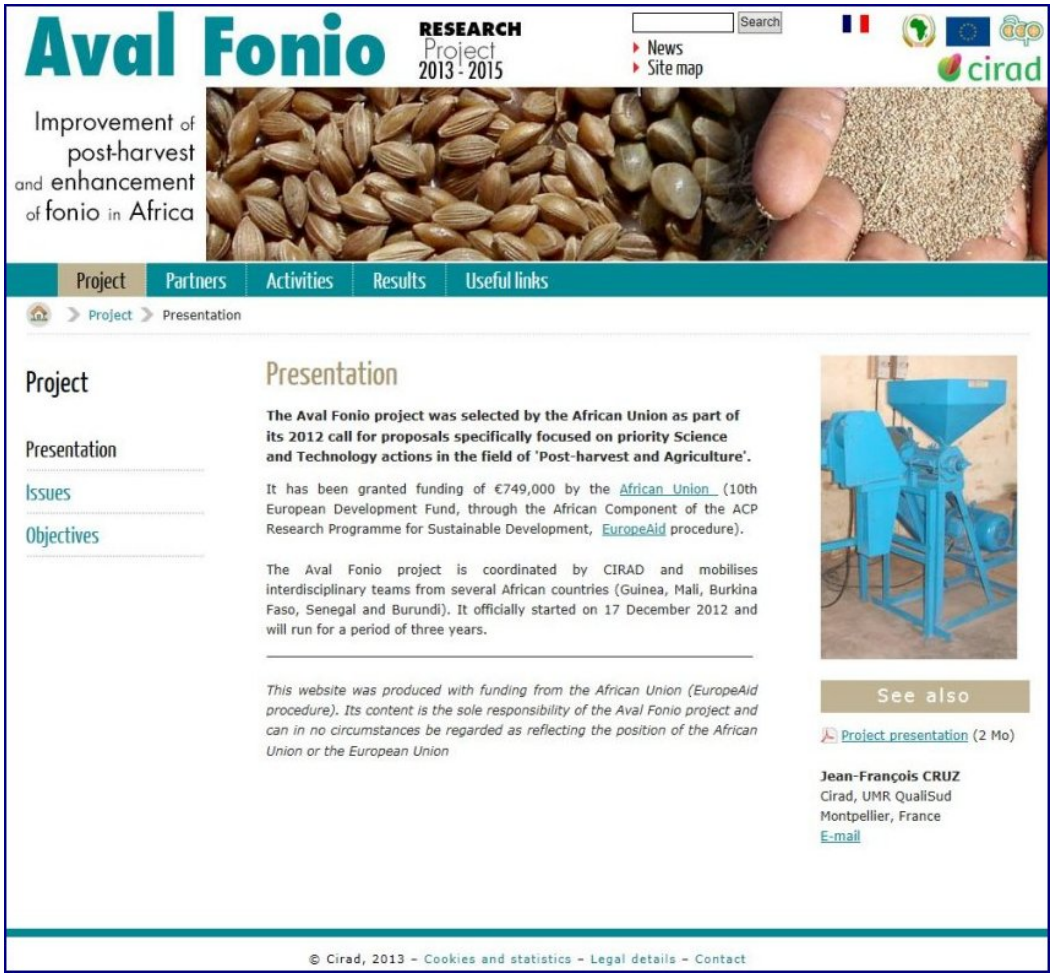


Figure 34. View of the "presentation" page of the "Aval Fonio" website

4.2. Participation in an international conference.

Two Cirad researchers participated in the 6th Global Food Marketplace conference (SIAL) held in Florianopolis (Brazil) in May 2013. They presented a poster referring to the "Aval Fonio" project:

Cruz J-F, Ferré T., Medah I., Goli T. 2013. Valorisation d'une céréale africaine: le fonio (Digitaria exilis Stapf). Cirad, Irsat, Syal. Congrès International des Systèmes agroalimentaires localisés (SYAL), Florianopolis, Brésil

Voir : http://aval-fonio.cirad.fr/resultats/publications

4.3. Visitors received at the Cirad agrifood technology platform

The Cirad agrifood technology platform receives a host of visitors all year round, and participates in the Science Festival organised in France in October. At each event, the "Aval Fonio" project coordinator (J-F. Cruz) presents to dozens of visitors the theme of "Rice and fonio in all their states", covering fonio post-harvest technology research in depth, and specifically referring to the "Aval Fonio" project.
(http://plateforme-technologie-agroalimentaire.cirad.fr/activites-de-la-plateforme/actualites/fete-de-la-science)

The European Commission may wish to publicise the results of Actions. Do you have any objection to this report being published on the EuropeAid website? If so, please state your objections here

No objections

Name of contact person for the "Aval Fonio" project: Jean-François CRUZ

Signature:

Location:
Cirad, Département Persyst, UMR Qualisud
73, rue J.F. Breton
TA-B-95/16
34398 Montpellier Cedex 5
France

Date report due: February 2014

Date report sent: April 2014

Annex

List of reports and publications

Reports

Blanc N. 2013. Recherche et étude de principes permettant le lavage et dessablage du fonio. Master 1 de mécanique. Université de Montpellier 2. Cirad. Montpellier, France. 58 p. + annexes

Cruz J-F. 2013. Réunion de démarrage et ateliers. Projet Aval Fonio. Cirad, Montpellier, 20 p. + annexes

Cruz J-F. 2013. Rapport de mission au Sénégal. Projet Aval Fonio. Cirad, Montpellier, 7 p.

Cruz J-F. 2013. Rapport intermédiaire. Projet Aval Fonio. Cirad, Montpellier, 20 p

Cruz J-F., Goli T, Ferré T. 2013. Rapport de l'atelier des WP3&4 à Ouagadougou (Burkina Faso). Projet Aval Fonio. Cirad, Montpellier, 25 p

Diallo T.A., Thaunay P., Loua F. 2013. Compte-rendu d'essais de matériel de récolte , de battage et de nettoyage réalises en Guinée. Projet aval Fonio. IRAG, Cirad Montpellier, 10 p.

Kebé C.M. F, Cissé M., Ayessou N. 2013. Compte - Rendu de mission au Sénégal oriental (Salémata et Kédougou) et au Mali (Kayes). Projet Aval Fonio. ESP-UCAD, Dakar, Sénégal. 11p.

Kane C., Anne A. A. 2013. Rapport de mission au Mali. Rencontre avec des transformatrices et des constructeurs d'équipements de transformation de fonio à Bamako. Projet Aval Fonio. ESP-UCAD, Dakar, Sénégal. 11p.

Martin C. 2013. Analyse des processus d'innovation dans la transformation du fonio au Burkina Faso. Projet Aval Fonio. Mémoire de fin d'étude. Montpellier SupAgro. Spécialité Systèmes Agricoles et agroalimentaires durables au Sud (SAADS). Montpellier, France. 110p. + annexes

Thaunay P. 2013. Formation Méthode de conception d'équipements à l'ESP-Ucad. Projet Aval Fonio. Activité 7.2., Cirad, 37 p. + annexes

Publications, poster…

Cruz J-F, Ferré T., Medah I., Goli T. 2013. Valorisation d'une céréale africaine: le fonio (Digitaria exilis Stapf). Cirad, Irsat, Syal. Congrès International des Systèmes agroalimentaires localisés (SYAL), Florianopolis, Brésil